

Science Modules

This module is an interdisciplinary unit that focuses on travel. If you are using Genesis science modules for the first time, read the [User's Guide](#) thoroughly before you begin. ([View User's Guide as PDF.](#))

The following classroom materials are available in Portable Document Format (PDF) for your browsing and printing convenience. The files are print-optimized, and should be printed to achieve maximum resolution. **Adobe's new Acrobat Reader 4.0 is required** to view and/or print. To install the FREE reader, visit the [Adobe Web site](#).

Take a look at additional [science modules](#) that are available on the Genesis Web site. All technical terms in the science modules are compiled in the [Glossary](#) for easy access.

[Technology Applications](#) are available for this module.



Destination L1: A Thematic Travel Unit

This module takes a thematic approach to the concept of traveling and destinations. All of the major disciplines are included in a unit that can be taught simultaneously in all classes lasting about one week. The context for this module is the million-mile journey that the Genesis spacecraft took to LaGrange point 1, also known as L1. Background information for this module includes the concept of L1 from a historical and mathematical perspective.

Module Planning Guide

What a Trip!

- [Teacher Guide](#)
- [Student Activity](#)

Introduction

This introductory activity will activate students' prior knowledge about traveling and the preparations they make to take a trip to a far - away place. Students use the Internet and travel books to plan a trip.

Curriculum Connections Life Skills Standards Addressed

Sets and manages goals

- Sets explicit long-term goals (K-12)
- Identifies and ranks relevant options in terms of accomplishing a goal (K-12)
- Prepares and follows a schedule for carrying out options (K-12)
- Establishes personal milestones (K-12)
- Identifies resources necessary to complete a goal (K-12)
- Makes a cumulative evaluation of goal (K-12)
- Makes contingency plans (K-12)

**Kepler's Laws of Planetary Motion**

- [Teacher Guide](#)

Round and Round

- [Student Activity](#)
- [Excel Spreadsheet Calculating Orbital Eccentricity of the Planets](#)

Sweepstakes

- [Student Activity](#)

The Inclined Pendulum

- [Student Activity](#)

L1 or Bust!

- [Student Text](#)

Students Get Down With Gravity

- [Webcast](#)

Science

The science activities in this module deal with the concept of travel as it relates to natural objects (planets) traveling around the sun. The activities are designed to let the students discover Kepler's Laws of Planetary Motion by completing assignments about the laws.

In the first activity, "Round and Round," students are given some historical context by reading background information about Nicolaus Copernicus, Tycho Brahe, and Johannes Kepler. Students then construct an ellipse using two different methods. They discover that planets orbit around the sun in elliptical orbits (first law). Using one of these ellipses, students are introduced to the concepts of the focus and the semi-major axis of an ellipse. Using these concepts, they determine the eccentricity of an ellipse and compare this with the relative roundness of the planetary orbits.

In the second activity, "Sweepstakes," students learn that as a planet travels around the sun, at different points it sweeps out equal areas in equal times (second law).

In the third activity, "The Inclined Pendulum," using a simulation, students model the fact that a decrease in gravity causes a decrease in orbital velocity and those more distant planets revolve around the sun at slower velocities (third law).

Finally, the students conclude by reading the Student Text, "L1 or Bust." They learn about the LaGrange Points and study the trajectory that is used by the Genesis spacecraft.

Mathematics

In "Minimum Energy Transfer Orbits," students will study the mathematics involved in having a spacecraft move from one orbit to another. They will use a mathematical formula derived from Kepler's Third Law of Motion (see "[The Inclined Pendulum](#)") to calculate the time of flight that a spacecraft would take to travel from Earth to another planet in our solar system using the minimum amount of energy. Students will look at the formula derived from Kepler's Third Law and make some simple calculations. Once students have calculated time of flight to one or more planets, they can use an Excel spreadsheet to investigate other transfer orbits as a technology application.

Minimum Transfer Orbits

- [Teacher Guide](#)
- [Teacher Guide Supplement](#)
- [Student Activity](#)
- [Student Reporting Sheet](#)

Hohmann Excel

- [Student Spreadsheet](#)

**Curriculum Connections
National Science Standards
Addressed****Science as Inquiry**

- Understandings about scientific inquiry (5-12)

Physical Science

- Motion and Forces (5-12)

Earth and Space Science

- Earth in the Solar System (5-12)

History and Nature of Science

- History of Science (5-8)
- Historical Perspectives (9-12)

**Curriculum Connections
National Mathematics
Standards Addressed****Numbers and Operations**

- Understand numbers, ways of representing numbers, relationships among numbers and number systems (6-8)
- Understand meanings of operations and how they relate to one another (6-8)
- Compute fluently and make reasonable estimates (6-8)

Algebra

- Use mathematical models to represent and understand quantitative relationships (6-8)
- Represent and analyze mathematical situations and structures using algebraic symbols (6-8)
- Understand patterns, relations and functions (9-12)
- Represent and analyze mathematical situations and structures using algebraic symbols (9-12)

Geometry

- Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships (6-8)
- Use visualization, spatial reasoning, and geometric modeling to solve problems (6-8)
- Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships (9-12)

Studying Orbits About Bodies in Space

- [Teacher Guide](#)
- [Teacher Guide Supplement](#)
- [Student Activity](#)
- [Student Reporting Sheet](#)

Kepler Excel

- [Student Spreadsheet](#)

Using a surprisingly simple relationship, Kepler's Third Law, we can study the orbit of a spacecraft about a body in space. We can study the basic parameters of (1) the time our spacecraft will take to circle the body once (called the "Period") and (2) its average distance from the body (we will call this "A"). Kepler came up with this law in 1619 after having spent the previous 19 years studying the best data on the orbit of Mars. This equation is empirical, that is, based on the very careful analysis of data.

Joseph-Louis LaGrange

- [Teacher Guide](#)
- [Student Text](#)
- [Student Activity](#)

Where on Earth?

- [Teacher Guide](#)
- [Student Activity](#)

View from Above

- [Student Activity](#)

What a Choice!

- [Teacher Guide](#)
- [Student Activity](#)

Social Studies

LaGrangian points are named after their discoverer, Joseph-Louis LaGrange, a French mathematician. Considered the greatest mathematician of his time, LaGrange mathematically discovered five special points in the vicinity of two orbiting masses where the combined gravitational forces are zero. In this activity, students study the life of LaGrange and create a sequence map of the important events in his life.

In "Where on Earth?" students review the concepts of latitude and longitude and use maps to determine latitude and longitude for several cities and the destinations they chose in "What a Trip!"

In "What a Choice!," students calculate the cost for each resource and develop a budget for the trip. They will also identify the choices they made in planning their trip and preparing the budget.

Science as Fiction

- [Teacher Guide](#)
- [Student Text](#)

A Space Story

- [Student Activity](#)

Getting to the Core of the Matter

- [Student Activity](#)

Can We Talk?

- [Teacher Guide](#)
- [Student Activity](#)

Language Arts

The language arts activities in this module focus on an understanding of the science fiction genre as it functions in literature, on reading comprehension, and basic writing strategies. The communication activities center around two strands of communication: verbal and non-verbal.

A technology communication theme that deals with both strands will also be utilized. Both disciplines use two short stories by Ray Bradbury that function as springboards for these activities. The first is "Golden Apples of the Sun," and the second is "The Wilderness."

Curriculum Connections

National Mathematics Standards Addressed

Geometry Continued

- Specify locations and describe spatial relationships using coordinate geometry and other representational systems (9-12)

Problem Solving

- Solve problems that arise in mathematics and in other contexts (5-12)

Connections

- Recognize and apply mathematics in contexts outside of mathematics (5-12)

Curriculum Connections

National History Standards Addressed

Historical Understanding

- Understands and knows how to analyze chronological relationships and patterns (5-8)
- Understands historical perspective (5-8)

National Geography Standards Addressed

The World in Spatial Terms

- Understands the characteristics and uses of maps, globes, and other geographic tools and technologies (K-12)

National Economics Standards Addressed

- Understands that scarcity of productive resources requires choices that generate opportunity costs (K-12)

- Alien Speak**
- [Student Activity](#)
- Capturing a Whisper**
- [Student Text](#)

Both stories are rich with opportunities to develop students' critical thinking and communication/language arts skills; both stories have a strong science application that advance science inquiry processes.

Before they begin, students will be asked to provide their own definitions of communication—a seemingly easy task that soon becomes complicated and always results in a spirited classroom discussion.

- School Trek**
- [Teacher Guide](#)
 - [Student Activity](#)

Culminating Activity

This activity engages students in preparing a travelogue, selecting the most appropriate means of presentation to share their school travel experiences with the class.

- Martin W. Lo**
- [Interview](#)
 - [Biography](#)

Interview

Read about Martin Lo, a JPL engineer who applies "chaos theory" to design trajectories like the one used by Genesis, using his LTool which has defined what he calls an "'InterPlanetary Superhighway': paths through space that depend on balanced-gravity points between planets."

Curriculum Connections

[National Language Arts Standards Addressed](#)

Reading

- Uses the general skills and strategies for the reading process (3-12)
- Uses reading skills and strategies to understand and interpret a variety of literary texts (3-12)
- Uses reading skills and strategies to understand and interpret a variety of informational texts (3-12)

Listening and Speaking

- Uses listening and speaking strategies for different purposes (3-12)

Curriculum Connections

[National Science Standards Addressed](#)

Assessment Standard B

- Achievement and Opportunity to Learn Science must be Assessed

Assessment Standard C

- Assessment Tasks Are Authentic

TEACHER RESOURCES

View a listing of [additional resources](#) that includes URLs, books, and periodicals.

This education module, *Destination L1: A Thematic Travel Unit*, was developed by educators at [Mid-continent Research for Education and Learning](#).



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